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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

This Issue

CENTRAL AIR-BORNE LUBRICATION SYSTEMS

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LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

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Central Air-Borne Lubrication Systems

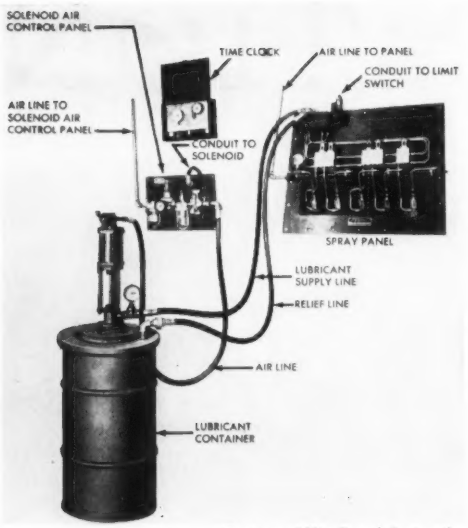
IS LUBRICATION of plant equipment a credit or a debit? Actually it can be either. If plant lubrication is regarded lightly; if it is considered nothing more than a necessary evil to be accomplished at the lowest possible cost; if it is not well organized; if the responsibility for lubrication of the equipment is placed in incapable hands; if, in selecting lubricants, price rather than quality is the determining factor; if lubricants are applied haphazardly — then lubrication certainly should go on the debit side of the books, since it will contribute directly to higher maintenance costs and increased down time, both of which mean greater production costs.

On the other hand, if plant lubrication is regarded as a means rather than an end; if all of the related factors and possible consequences are given serious consideration; if a well organized lubrication program is adopted and sound practices are observed; if the responsibility is placed in capable hands — then lubrication will definitely be a credit since it will contribute directly to decreased maintenance costs and less down time, both of which mean lower production costs.

This is a companion article to the August issue which was devoted to a discussion of automatic systems for dispensing greases. Since the basic principles of the conventional type centralized systems are similar regardless of whether grease or oil is being handled, this issue features a discussion of the unconventional but very important systems which use air as the lubricant carrier.

Fifty years ago lubrication was a relatively simple matter. The requirements were mild and the lubricants were few. The consumer had little problem in selecting proper lubricants and even less of one in applying them. It mattered little whether equipment was over-lubricated, under-lubricated or lubricated at all in some cases. In fact, lubrication was considered to be of such minor importance that responsibility for it was usually assigned to personnel thought to be incapable of performing any other task.

The tremendous technological strides made during the intervening years have changed this picture completely. Countless new lubrication requirements have arisen, and the conditions under which the lubricants must perform have become increasingly more severe. The number of lubricants has grown from a mere handful to literally hundreds of products, many of which are tailor-made for specific applications or conditions. Automation has also exerted a major influence on the current attitude toward lubrication. In automated plants it is vital that each piece of machinery be kept in operation, since the breakdown of a single unit might halt all production. Proper lubrication is perhaps the most important single factor in keep-



Courtesy of The Farrel Corporation

Figure 1 – Typical Automatic Spray System Layout.

ing the machines running.

The responsibility for successful lubrication rests not with the equipment manufacturer, nor with the lubricant supplier, but squarely on the shoulders of the equipment users. It is they who must select the lubricants to be employed and apply them to the equipment to be lubricated. One of the most significant and encouraging signs in the field of industrial lubrication during recent years is the awakening of plant management to the overall savings and other benefits that can be realized from a well-planned, sound lubrication program. Regardless of the size of the plant, whether it be small or large, organized lubrication conducted by competent personnel is bound to pay dividends.

One of the most important features of any successful lubrication program is the application of the lubricant. The best lubricant in the world is of no value until it is applied and applied properly to the bearings or other surfaces to be lubricated. In fact, proper application of a lubricant is equally as vital to the satisfactory performance of a machine as the selection of the right product.

Years ago, it was the accepted practice for the "oiler" or "grease monkey," armed with the familiar squirt can and grease gun, to make his rounds of the machines and apply the lubricants where needed. Although it was notoriously inefficient and had many drawbacks, this method was quite adequate at the time. The number of points to be lubricated on old machines were few and because of the slow speeds, light loads and large clearances, lubrication was not a critical item.

However, the design of modern machines practically precludes the use of such primitive, inefficient methods of applying lubricants. Not only are the bearings in today's equipment far more numerous, but they are precision-built to operate at much more severe conditions. Satisfactory operation depends not only on the right lubricant, but also on the right amount applied at the proper time. Thus, controlled application is essential. Furthermore, the size of the average industrial plant has increased many-fold over the years. All factors considered, it is just too much to expect an oiler, equipped with a grease gun or squirt can, to locate every point that requires lubrication and see that it is lubricated properly. Modern machines require devices for lubricant application which are as independent as possible of the human element. On the surface at least, it would appear that this is pure common sense. However, there is still a large segment of industry relying on out-moded methods of applying lubricants to maintain and protect its expensive production equipment. Many times a mechanical failure may be blamed on the lubricant, when actually the application is faulty.

BENEFITS OF CONTROLLED APPLICATION OF LUBRICANTS

The benefits to be realized from a policy of "controlled lubrication," using the modern methods of application, are many. Some of the advantages are described briefly as follows.

Lower Operating Costs

The cry "reduce operating costs" is being echoed today throughout industrial plants all over the country. One avenue that leads to reduced costs is controlled lubricant application.

Years ago it was economical, although inefficient, to lubricate machinery by hand. Today, labor is not cheap. In one plant where manual lubrication was still being used, it was estimated that it was costing $4.00 in labor to apply $1.00 worth of lubricant. The total annual labor costs for applying lubricants in this plant ran close to $110,000. The use of modern methods of application could have slashed this figure substantially, and at the same time reduced lubricant costs, since manual application invariably is accompanied by waste.

Less Downtime

The companion cry to "reduce operating costs" is "maintain production." Shutdown to permit lubrication of equipment is lost production time that a plant can ill-afford. In plants which still rely on manual methods of applying lubricants, much valuable time is lost because of the necessity of stopping machines to apply the lubricant. As an example, in an automotive plant it was found that it required an oiler 18 minutes to lubricate a cylinder block boring

machine. Multiply this by the number of machines in a plant and the number of lubrication cycles per day and it is readily apparent that the amount of "time-out" for lubrication could be appreciable.

The Right Amount At The Right Time

How much lubricant and how often? The answer to this, of course, depends on the size and type of bearing, the load and speed, and the environment. For each bearing and set of operation conditions, there will be an optimum quantity of lubricant that should be applied and an optimum lubrication cycle. For example, a large high speed drive shaft may require a shot of oil every few minutes. A small bearing may need only a drop of oil every hour or so. Outmoded hand lubrication methods invariably will produce a feast or a famine, either one of which can produce some very unpleasant, if not disastrous, consequences. Modern methods of application assure that each bearing gets its quota of lubricant, and only its quota, at the proper time.

No Guess Work

It is not uncommon for a complex piece of machinery to have over 200 bearings. Experience has shown that it is impossible for any crew of oilers, regardless of how conscientious they may be, to lubricate these bearings manually with any degree of accuracy. Here the old adage "Out Of Sight Out Of Mind" is working overtime. With modern methods of application, however, all bearings, not just the obvious ones, are lubricated.

No Inaccessible Bearings

In addition to bearings hidden from view, many bearings or other parts to be lubricated are practically inaccessible to manual lubrication. In order to lubricate these points, the equipment must be partially dismantled, which not only is a nuisance, but also takes up valuable time. With modern methods of application there are no inaccessible bearings.

Longer Machinery Life

The cost of one industrial machine may run well up into the hundreds of thousands of dollars. Thus, the investment in equipment for even an average size plant could be astronomically large. With such a large investment, it is only natural that the user wants to extend the life of his machines as long as possible. Proper lubrication, of course, is one of the main factors leading to long equipment life, and controlled application of the lubricant is one of the most important phases of proper lubrication. Modern methods of application can be a great help in extending machinery life.

No Contamination

A good portion of equipment maintenance costs can be attributed directly to a contaminated lubricant. Manual methods of application invite contamination. Modern methods of application practically preclude it.

Promotes Safety

All plants are becoming more safety conscious. It is generally forbidden to lubricate a machine manually while it is in operation. Frequently the rules are overlooked, and in these cases lubricant application is a definite hazard.

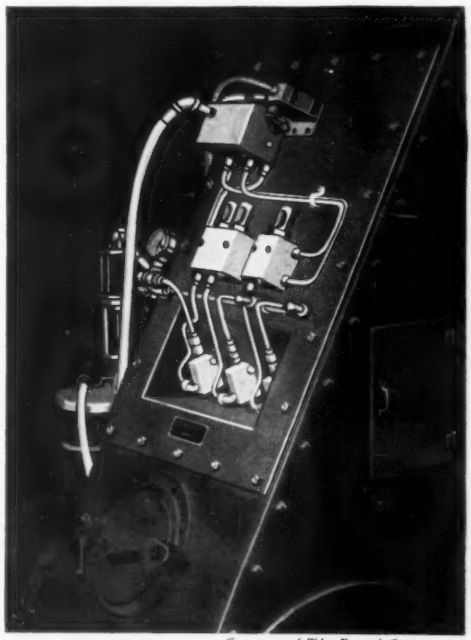
Even when the machines are stopped, it may be necessary for the oilers to climb ladders, sometimes at dizzy heights, to lubricate a bearing.

With manual methods of application the lubricant is not always confined to the bearings. The machine surfaces are usually covered and the floors become oil soaked, presenting another hazard.

Modern methods eliminate these hazards.

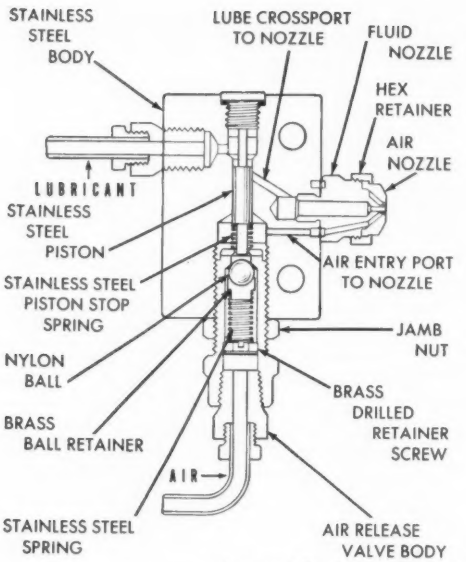
These, then, are some of the obvious benefits to be realized by controlled application of lubricants, all of which will contribute handsomely toward reduced costs and increased production.

Surveys of plant lubrication practices have revealed some astounding findings, not only with regard to the wide extent of malpractices and the resultant costs thereof, but also as to the amount of overall savings that have been realized by the correction of these practices. Inefficient methods, lack



Courtesy of The Farvel Corporation

Figure 2 — Close-Up of Panel Showing Installation of a Three Nozzle Automatic Spray Lubrication System on a Ball Mill.



Courtesy of The Farrel Corporation

Figure 3 — Cutaway View of a Spray Valve.

of standardization of techniques for applying lubricants within a plant or even on one piece of machinery, and dependence on the human element are three common factors which are at the root of most bad lubrication practices. The following actual case history will serve as a striking illustration of these points.

A study was made of the lubrication practices as related to 60 machine tools which perform multiple machining operations including turning, boring, drilling and reaming. These machines had been in operation for ten years, and the operators were assigned the responsibility of lubricating the tool slides. They were furnished with hand grease guns and were supposed to devote fifteen minutes of every eight hour shift to lubricate the twenty-one points on each machine. The result of the study revealed that the tool slides either were being lubricated improperly or had not been lubricated for a long time. The reasons for this condition were found to be numerous and varied, including the following: neglect on the part of the operator; new operator not properly instructed to his responsibility; grease gun lost or misplaced; no grease on hand; fittings damaged or missing.

These conditions were corrected by installing a central system on each machine and relieving the operators of the responsibility for lubrication. The results that followed were amazing. Maintenance costs was reduced sixty percent. Production from these machines was increased twenty percent. The quality of the work was better. The amount of rejects was decreased substantially because with proper lubrication, size and finish were maintained more consistently. These factors all added up to tremendous savings and greatly improved operations.

This experience has been repeated over and over again in plants where measures have been taken to correct faulty, inefficient methods of applying lubricants and is typical of the benefits that can be realized.

MODERN LUBRICATION EQUIPMENT

There are many varieties and types of equipment available for applying industrial lubricants, ranging from devices to lubricate a single bearing to fully automatic central systems capable of lubricating all of the machinery in a plant. Each of these satisfies a need and occupies a definite niche in the general field of lubrication.

Central Systems

Centralized lubrication systems which supply measured quantities of lubricant to all the bearings of a machine or group of machines are now being employed extensively on industrial equipment. Although they vary widely in design, all systems have three basic features in common, namely (1) a pump or some other positive means of delivering lubricant from a reservoir and forcing it through (2) a distribution system of piping or tubing to, (3) measuring or metering devices which regulate the amount of lubricant that is applied to each bearing. Centralized lubrication can be installed on equipment already in use, or it can be built into a machine at the time of manufacture. With the growing realization that lubrication is no longer simply a maintenance item but actually a necessary component of the equipment, more and more machinery builders are installing centralized systems as an integral part of their machines.

New developments during the last ten years in the field of lubricant application have produced the centralized air-borne systems, in which the lubricant is applied as a spray or even more finely atomized, as a fog or mist. Although these are specialized adaptations of the centralized systems and must not be regarded as a cure-all, they do have a definite place in the lubrication of industrial equipment and in certain cases provide some additional benefits over those provided by the conventional systems.

Spray Lubrication

Spray systems are particularly well suited for lubricating heavy, open gears and sliding surfaces. They are especially good for applying the diluent or cut-back type lubricants which depend upon evaporation of the solvent to leave the tough film required to carry gear loads and protect gear surfaces.

Although open gears are generally regarded as being on the way out, there are still many thousands of installations which will be in use for years to come. Furthermore, due to the high cost of enclos-

ing them, open gears are still being installed on some new equipment such as presses, ball mills, kilns, and machines for paper mills and sugar mills.

Normally, these gears are lubricated by swabbing, brushing, pouring, dipping and dripping. With all of these methods there is a large amount of throw-off and drippage, which is unsightly and creates a safety hazard. The excessive consumption is costly, and furthermore there is hardly a uniform distribution of lubricant over the gear teeth. The spray methods ensure proper coating of the gears, in measured amounts, at regular intervals. Also it is estimated, on the basis of actual installations, that lubricant consumption is reduced about 75%.

Typical Systems

Figure 1 shows a typical layout for one type of automatic system designed to operate in conjunction with an air pressure of 80 psi. An adjustable time clock starts each lubrication cycle by energizing a solenoid-operated air control valve on the air control panel. Pre-set air pressure is applied to the air operated pumping unit which delivers lubricant from the supply drum to the spray panel through a hydraulic reversing valve.

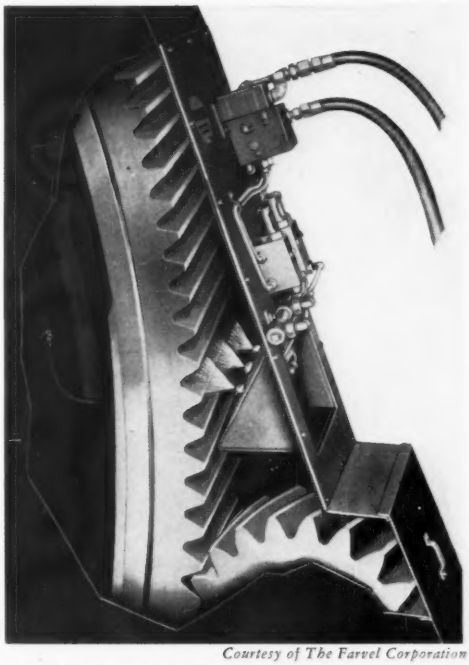
As lubricant enters one of the supply lines leading to the measuring valves, the measuring pistons force a predetermined amount of lubricant through the valve discharge lines to the spray control and nozzles where the air stream atomizes the lubricant and carries it to the gear surfaces. Since the amount of air used is controlled by the amount of lubricant discharged at each nozzle, an adjustment of the measuring valve automatically increases or reduces air consumption.

After all measuring valves have discharged the predetermined quantity of lubricant, a switch is tripped automatically ending the lubrication cycle and the system prepares itself, also automatically, for the next cycle.

Figure 2 is a close-up of the panel of a three nozzle automatic spray lubrication system installed on a ball mill. The control switch is located at the top of the panel and directly below are the three measuring valves. These supply a measured amount of lubricant to the three spray valves which are recessed into the gear guard. Notice the inspection door located on the gear guard at right angles to the gear face and adjacent to the location of the spray nozzles. This permits easy, periodic inspection of the spray pattern.

Spray Valve

A cutaway view of a spray valve is shown in Figure 3. As a measured amount of lubricant enters the valve, a control piston opens an outlet port which directs the lubricant to the nozzle. Simultaneously, a ball check is unseated to permit a flow of air to the nozzle. The air and lubricant are mixed just outside the nozzle tip to form a spray. After the measured quantity of lubricant has been discharged, the valve shuts off automatically until the next cycle. With the adjustable cycling of the system and the adjustable metering valves, any desired quantity of lubricant can be sprayed onto a gear in a given period of time.



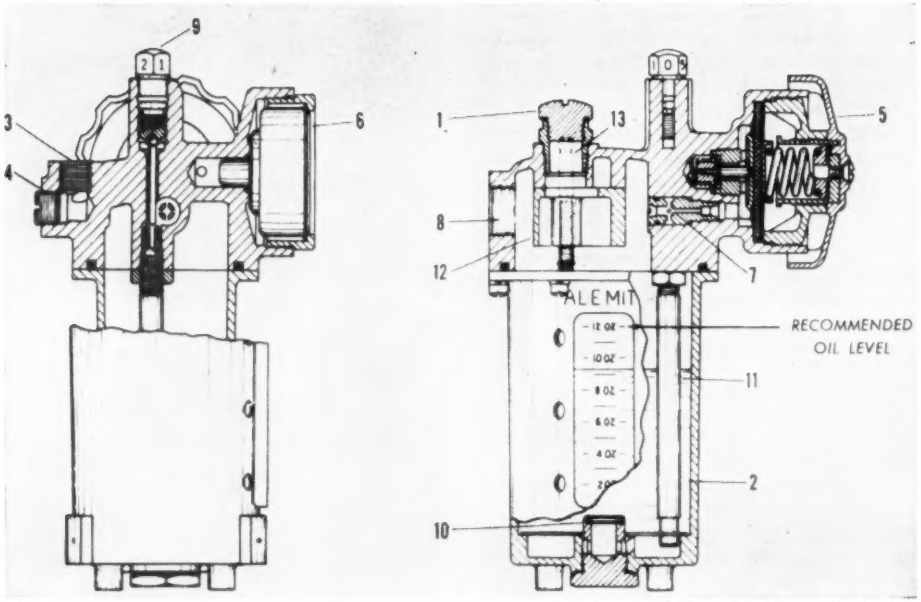
Courtesy of The Farval Corporation

Figure 4 – Schematic Cutaway Showing Spray Valve Lubrication Coverage of a Typical Gear and Pinion Installation.

Pneumatic atomizing nozzles may be of two basic types – those in which the atomization takes place inside the nozzle tip and those where it takes place outside the tip. Furthermore, the sprays can be classified as round, wide angle round, or flat. Studies have indicated that external atomization and a round spray are best suited for applying lubricants of the diluent type. The chief advantages of external atomization is that the nozzle is not susceptible to plugging, as the full pressure of the system is effective in flushing the fluid orifice during each cycle. With internal atomization using a diluent type lubricant, there is danger of plugging the discharge orifice should the lubricant dry out or harden between spray cycles.

Installation Considerations

Gear speed, pitch diameter and gear face must all be considered when installing a spray system for applying lubricants. Gear speed will determine the frequency of the lubricating cycles and the size of the measuring valve. Because of its direct relation



Courtesy of Alemite Div. Stewart Warner Corp.

Figure 5 — Schematic Cutaway of an Oil Mist Lubricator.

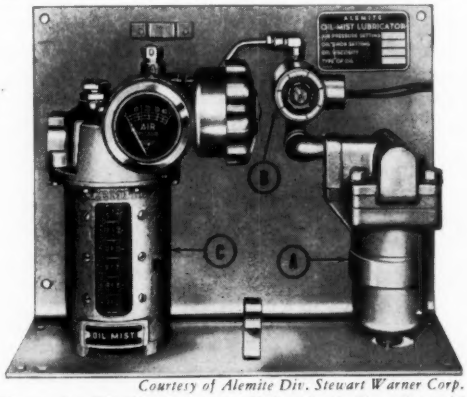
to gear circumference, pitch diameter adds a consideration of centrifugal force to that of speed as the gear size increases. The possibility of lubricant throw-off due to centrifugal force is an additional factor which must be considered in figuring the frequency of the cycle and the size of the valves. The face width and type of gearing dictate not only the number of spray valves required, but their individual adjustment as well.

The point at which the spray is directed is, of course, of vital importance. The nozzle should be located so that the lubricant spray is directed to the pressure side of the gear teeth. At first thought it might appear that the ideal spot for spraying lubricant on a gear and pinion is at the point of mesh. On many gear and pinion sets, however, the air turbulence at the point of mesh, resulting from air ejection of the meshing teeth, is sufficiently strong that the lubricant spray cannot penetrate the back currents satisfactorily. Figure 4 is a cutaway view of the installation of an automatic spray panel on a ball mill.

With respect to the type of lubricant which can be employed in a spray system, the limiting factor is the pumpability of the lubricant. If the lubricant cannot be pumped, it cannot be handled in a centralized metered spray system.

Atomized Lubrication

The need for continuous controlled lubrication for high rotational speed, anti-friction bearings and the desire to prevent abrasives in the atomizer from penetrating these bearings were instrumental in promoting the development of the new atomized lubrication systems. Actually the principle of atomized lubrication is not new, since it was applied many years ago and still is to the lubrication of pneumatic tools. However, the current systems which were designed especially for bearing lubrication differ radically from those used for the air tools. For example, the devices for lubricating air tools are characterized by (1) high pressure air discharge, (2) non-uniform sized oil particles, (3) high oil consumption, and (4) oil distribution usually lim-



Courtesy of Alemite Div. Stewart Warner Corp.

Figure 6 — Oil Mist Lubricator With Air Purifier, Solenoid Valve and Air Regulator.

ited to a single feed line. On the other hand, the centralized atomized systems for bearings are characterized by (1) extremely low pressure discharge, (2) uniform, minute oil particles (3) very low oil consumption and (4) equal oil distribution from multiple feeder lines over long distances.

For the systems under consideration here, oil is atomized in a central lubricator by compressed air into very minute particles and is carried in the atomized state from the reservoir through suitable tubing to the individual bearings and other points to be lubricated. Systems of this type are intended to obtain the maximum lubricating efficiency from each drop of oil, and at the same time to derive additional cooling benefits from the air. Furthermore, with lubricating systems of this type there will always be a positive pressure on the bearing which will tend to keep contaminants out. In many instances seals can be eliminated completely. Also, the consumption of lubricant is measured in terms of ounces per day rather than gallons.

Before about 1950 it was generally considered that atomized lubrication was limited to and effective only when applied to small high speed precision bearings. Today the size of the bearing or bearing surface presents no obstacle. The basic theory of lubricating bearing surfaces is the same regardless of whether the bearings be small or large. Consequently, today atomized lubrication is being used successfully to lubricate high speed anti-friction bearings fitted to a 0.09 inch diameter shaft in a dental hand piece, as one extreme, and also 4-row anti-friction bearings fitted to 34 inch diameter shafts in a rolling mill on the other extreme. In between are thousands of successful applications on a wide variety of machines used throughout industry including such equipment as transfer machines, automatic screw machines, hand screw machines, textile machinery, paper processing equipment, conveyors and high speed grinders.

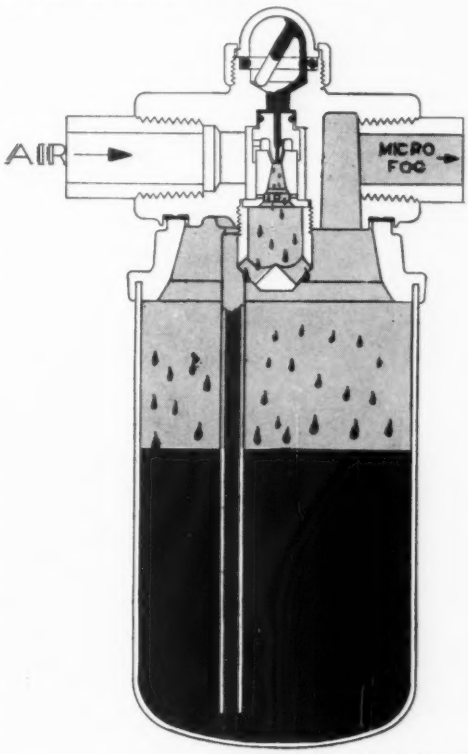
Lubricators

Generally the basic components of an atomized system will consist of a lubricator in which the oil is atomized, the distribution system, and the fittings connecting the distribution system to the bearing.

A cutaway view of one type of lubricator is shown in Figure 5. The unit is filled with oil through the inlet (1) to the recommended level in the reservoir (2). An air supply is connected to the unit, and if the operation is to be completely automatic, the supply line is connected to a solenoid-operated air valve which is connected by a tube to points (3) or (4). Compressed air passes through the air regulator (5), where it is reduced to the desired operating pressure which is indicated on the air gauge (6). The air at low pressure then flows through the venturi (7). When the oil flow regulator (9) is opened, oil is drawn through the filter (10) to the spray tube (11) into the venturi (7) where it is atomized by the air flow. The oil and air mixture is thrust against a baffle (12) which collects the large particles of oil and returns them to the reservoir. The air leaving the lubricator at outlet (8) is completely saturated with only very minute oil particles.

The heart of this particular lubricator is the baffle plate which ensures that only particles of oil lighter than air pass from the lubricator. The effectiveness of the baffle plate in rejecting heavy oil particles is illustrated by the fact that less than 0.5% of the oil which is thrust against it escapes as mist.

Figure 6 shows this lubricator and its controls mounted together and ready to be installed. The incoming air passes first through an air purifier (A) which removes most of the moisture and foreign particles from the air. The flow of air is controlled by the solenoid valve (B). Line air pressure is reduced by the adjustable air regulator and the gauge registers the pressure entering the lubricator (C). The oil reservoir has a transparent nylon window so that the oil level is always visible.



Courtesy of C. A. Norgren Company

Figure 7 – Schematic Cutaway of a Micro-Fog Lubricator Illustrating the Principle of Oil Atomization.

Courtesy of C. A. Norgren Company

Figure 8 — An Integrated Micro-Fog Lubricator Showing the Filter and Air Gage.

Another typical lubricator is shown in Figure 7. Air entering the lubricator head is forced past a venturi section in a downward direction. This results in a differential pressure between the oil reservoir and the sight feed dome above, which causes oil to circulate from the reservoir to the sight feed dome and thence into the venturi section. The air velocity passing through the venturi section causes the oil to be atomized into very fine particles. Those particles which are heavier than air return to the reservoir, while those lighter than air enter the manifold system down stream from the lubricator and pass into the distribution lines. Figure 8 is a photograph of an integrated lubricator.

The atomized lubricant leaves the lubricator under slight pressure and is carried through the distribution lines at very low velocity. In these lines, the mist or fog has no lubricating properties whatsoever and can be considered completely "dry". The concentration of oil particles is so small that the mixture is non-flammable, and neither heat nor cold will have any effect on the oil particles in the lines. The oil content of the mixture at the most remote end of a system will be over 98% of what it was as it left the lubricator. Thus, there is no problem due to lubricant settling out in the lines.

If the atomized mixture in the distribution system is "dry" and possesses no lubricating ability then, obviously, it must undergo a change at the time it is applied to the bearings. There are two basic ways by which this "dry" atomized oil can be converted to "wet" oil. One is by meeting mass in motion, and the other is by an increase in velocity. A rotating bearing, of course, is mass in motion and will cause the atomized oil to condense. Also, just prior to contacting the bearing, the velocity may be increased by the use of certain types of fittings or reclassifiers. In fact, by use of the proper fitting the oil can be applied as a mist, a spray, or a solid stream.

General Considerations

It has become customary to speak of the capacity of these systems in terms of the number of bearing inches they can lubricate. The term "bearing inch" relates to the shaft diameter, one inch of shaft diameter equalling one bearing inch. Thus, for example, a lubricator with a rating of 30 bearing inches could handle 30 anti-friction bearings on one inch shafts, of one bearing on a 30 inch shaft.

Since plant air is used to atomize the lubricant in these systems, it is very important that it be free of contaminants such as pipe scale, pipe dope and condensate which are normally present in all industrial compressed air lines. Consequently, a good filter is required immediately up stream of the lubricator. It is suggested that one be used which has a filter element capable of removing all solid material larger than 25 microns. The filter should also have provision for automatically discharging accumulated condensate and compressor oil.

The viscosity of an oil will have an appreciable effect on its atomizing characteristics, and consequently there is an upper limit on oil viscosity that can be used in these atomized systems. The heaviest oil that will atomize satisfactorily is one having a viscosity of 1000 seconds at 100°F. Usually, arrangements can be made to install a thermostatically controlled heater in the lubricator to maintain a uniform lubricant temperature and viscosity.

Unless these systems are grossly maladjusted, they will not dispense a noticeable amount of atomized lubricant into the plant atmosphere. As mentioned previously, these systems are not cure-alls and cannot be used satisfactorily to solve all lubrication problems. However, during the past five or six years they have become established tools of the industry and are proving their worth in countless applications.

SUMMARY

Satisfactory lubrication of modern industrial equipment depends on the application of the correct amount of proper lubricant at the right time. No matter how good a lubricant may be, it cannot function and serve its purpose until it is applied to the area to be lubricated. Proper application is just as important to the satisfactory performance of a machine as the selection of the right product.

Modern methods of lubricant application provide numerous benefits and advantages, all of which add up to lower operating and maintenance costs and high production rates. Centralized Air-Borne Lubrication Systems, although relatively new and limited in their application, are rapidly taking their rightful place in the field.

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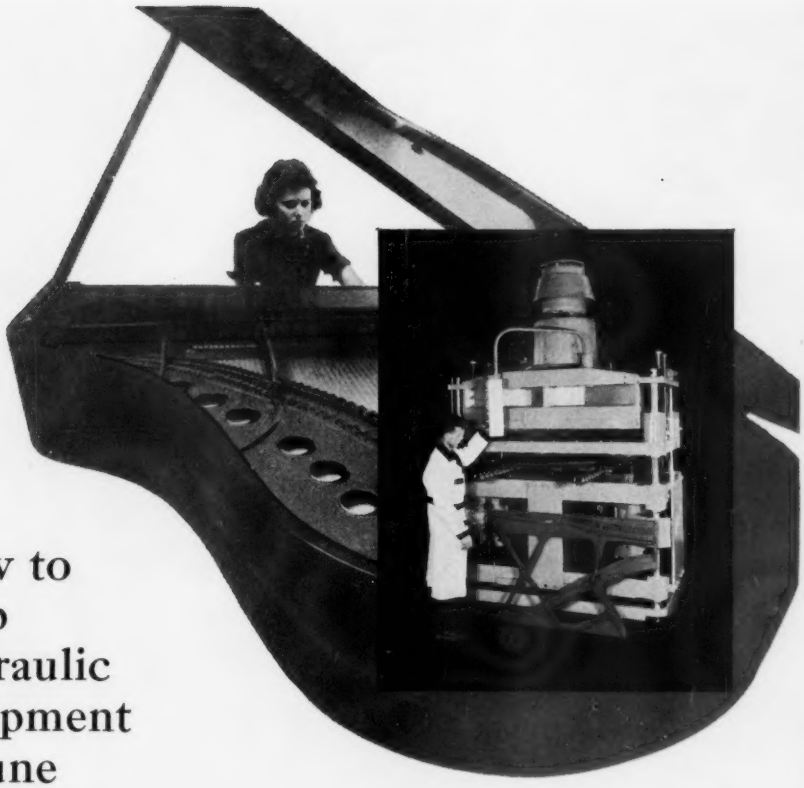

How to keep hydraulic equipment in tune

The multiple-spindle machine, shown above, is used in the production of cast iron harps for pianos. It drills 417 holes at one time—from 5/32″ to 7/16″. The large number of spindles makes lubrication a critical factor in keeping production humming.

That's why the machine manufacturer—Zagar Tool, Inc., Cleveland, Ohio—specifies *Texaco Regal Oil R & O* both as a spindle lubricant, and in the hydraulic system which controls the feed of the drills.

Texaco Regal Oil R & O has much greater oxidation resistance than ordinary turbine-quality oils used in hydraulic service. It effectively prevents rust and foam—assures smoother, more dependable service.

There's a complete line of *Texaco Regal Oils R & O*. Let a Texaco Lubrication Engineer help you select the one best for your job. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

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